

## CLAIMS

1. A top drive swivel insertable into a drill or work string comprising:
  - (a) a mandrel having upper and lower end sections and connected to and rotatable with upper and lower drill or work string sections, the mandrel including a longitudinal passage forming a continuation of a passage in the drill or work string sections;
  - (b) a sleeve having a longitudinal sleeve passage, the sleeve being rotatably connected to the mandrel by a pair of longitudinally spaced bearings;
  - (c) a seal between upper and lower end portions of the mandrel and sleeve, the seal preventing leakage of fluid between the mandrel and sleeve;
  - (d) the sleeve comprising an inlet port positioned between the spaced bearings; and
  - (e) the mandrel comprising a plurality of longitudinally spaced apart radial ports in fluid communication with both the inlet port and the longitudinal passage to supply pressurized fluid from the inlet port to the longitudinal passage and in the passage in drill or work string sections.
2. The top drive swivel of claim 1, wherein the mandrel and sleeve further comprise a peripheral recess, the peripheral recess being located between the longitudinally spaced bearings and being in fluid communication with the inlet port and the plurality of spaced apart radial inlet ports.
3. The top drive swivel of claim 1, wherein the mandrel further comprises a shoulder and a retaining nut threadably engaging the mandrel, the shoulder and retaining nut being spaced apart, the sleeve being positioned between the spaced apart shoulder and retaining nut.
4. The top drive swivel of claim 1, wherein the seal further comprises a pair of spaced apart packing units; the sleeve further comprises a protruding section in the longitudinal sleeve passage, each of the packing units being located on opposite sides of the protruding section.

5. The top drive swivel of claim 3, wherein the retaining nut further comprises a set screw threadably engaging the retaining nut, and wherein the mandrel further comprises a plurality of receiving portions, the set engaging one of the receiving portions and locking the retainer nut in position on the mandrel.

5 6. The top drive swivel of claim 3, wherein the retaining nut further comprises a lubrications port, the lubrication port being positioned to lubricate at least one of the spaced bearings.

7. The top drive swivel of claim 1, wherein the plurality of longitudinally spaced apart radial ports are also circumferentially spaced.

8. The top drive swivel of claim 1, wherein the longitudinally spaced bearings comprise roller bearings inclined in relation to a longitudinal axis of the mandrel.

15 9. A top drive swivel incorporated into a well string rotatably driven by a top drive unit, the swivel comprising:

(a) a rotatable mandrel having an axial flow passage therethrough, the mandrel having upper and lower ends connected with sections of the well string for rotation therewith, and

20 (b) a sleeve extending peripherally around the mandrel and rotatably connected to the mandrel by support bearings and seals interconnecting end portions of the mandrel and sleeve,

(c) an inlet in the sleeve for connection with a high pressure fluid source,

25 (d) a plurality of ports in the mandrel in communication with the sleeve inlet port for introducing high pressure fluid into the axial flow passage in the mandrel and into the well string,

(e) the mandrel including a peripheral recess area aligned with the inlet port in the sleeve and in communication with the plurality of ports in the mandrel and the axial flow passage.

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10. A top drive swivel insertable into a drill or work string comprising:
- (a) a mandrel having upper and lower end sections and connected to and rotatable with upper and lower drill or work string sections, the mandrel including a longitudinal passage forming a continuation of a passage in the drill or work string sections;
  - (b) a sleeve having a longitudinal sleeve passage, the sleeve being rotatably connected to the mandrel by a pair of longitudinally spaced bearings;
  - (c) a seal between upper and lower end portions of the mandrel and sleeve, the seal preventing leakage of fluid between the mandrel and sleeve;
  - (d) the sleeve comprising an inlet port positioned between the spaced bearings;
  - (e) the mandrel comprising a plurality of spaced apart radial ports in fluid communication with both the inlet port and the longitudinal passage to supply pressurized fluid from the inlet port to the longitudinal passage and in the passage in drill or work string sections; and
  - (f) a clamp, the clamp being detachably connected to the sleeve.
11. The top drive swivel of claim 10, wherein the sleeve further comprise a peripheral groove, the clamp fitting in the groove, and wherein the clamp comprises first and second portions, the first and second portions being detachably connectable to each other.
12. The top drive swivel of claim 11, wherein the clamp and sleeve further comprise a key, the key fitting between the clamp and sleeve and restricting relative rotational movement between the clamp and sleeve.
13. The top drive swivel of claim 12, wherein the clamp and sleeve further comprise a second key, the second key fitting between the clamp and sleeve.
14. The top drive swivel of claim 11, wherein at least one bolt detachably connects the first and second portions.
15. The top drive swivel of claim 10, wherein the clamp further comprises a plurality of shackles connected to the clamp.
16. The top drive swivel of claim 10, wherein the clamp further comprises at least one torque arm connected to the clamp.

17. The top drive swivel of claim 16, wherein the clamp comprises two torque arms.

18. The top drive swivel of claim 11, wherein the first and second portions of the clamp are each in the shape of a half moon.

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19. A top drive swivel insertable into a drill or work string comprising:

(a) a mandrel having upper and lower end sections and connected to and rotatable with upper and lower drill or work string sections, the mandrel including a longitudinal passage forming a continuation of a passage in the drill or work string sections;

(b) a sleeve having a longitudinal sleeve passage, the sleeve being rotatably connected to the mandrel by a pair of longitudinally spaced bearings;

(c) a seal between upper and lower end portions of the mandrel and sleeve, the seal preventing leakage of fluid between the mandrel and sleeve;

(d) the sleeve comprising an inlet port positioned between the spaced bearings;

(e) the mandrel comprising a plurality of spaced apart radial ports in fluid communication with both the inlet port and the longitudinal passage to supply pressurized fluid from the inlet port to the longitudinal passage and in the passage in drill or work string sections; and

(f) a packing port, the packing port being in communication with the seal and allowing the insertion of additional packing material into the seal.

20. The top drive swivel of claim 19, wherein the seal further comprises a pair of spaced apart packing units one of which being in communication with the packing port, and wherein the swivel further comprises a second packing port, the second packing port being in communication the packing unit not in communication with the packing port, the second packing port allowing the insertion of additional packing material.

21. The top drive swivel of claim 20, wherein each packing unit further comprises a packing injection ring, each packing ring being in communication with a packing port.

22. The top drive swivel of claim 21, wherein each packing injection ring

comprises a plurality of radial ports spaced circumferentially around each packing injection ring, and a plurality of transverse ports, each transverse port intersecting one of the plurality of radial ports.

5           23.     The top drive swivel of claim 22, wherein each radial port terminates at its intersection with its respective transverse port.

          24.     The top drive swivel of claim 22, wherein each radial port extends through the packing injection ring.

          25.     The top drive swivel of claim 21, wherein each packing injection ring comprises a peripheral groove.

10           26.     The top drive swivel of claim 25, wherein each packing injection ring comprises an interior groove.

          27.     The top drive swivel of claim 25, wherein each packing injection ring comprises a male end and a flat end, the male end being opposed to the flat end, and the transverse ports running between the male and flat ends.

15           28.     The top drive swivel of claim 22, wherein there are eight radial ports and eight transverse ports equally spaced around each packing injection ring.

          29.     The top drive swivel of claim 19, further comprising an injection fitting connected to the packing injection port.

          30.     The top drive swivel of claim 20, further comprising first and second injection fittings connected to the two injection ports.

          31.     The top drive swivel of claim 20, further comprising first and second pressure relief fittings connected to the two injection ports.

          32.     The top drive swivel of claim 20, further comprising a cover, the cover being placed around one of the two injection ports.

25           33.     The top drive swivel of claim 32, the swivel further comprising a clamp, the clamp connected to the sleeve, and wherein one injection port is located between the clamp and the sleeve inlet.

          34.     A top drive swivel insertable into a drill or work string comprising:  
30           (a) a mandrel having upper and lower end sections and connected to and rotatable with upper and lower drill or work string sections, the mandrel including a

longitudinal passage forming a continuation of a passage in the drill or work string sections;

(b) a sleeve having a longitudinal sleeve passage, the sleeve being rotatably connected to the mandrel by a pair of longitudinally spaced bearings;

5 (c) a pair of spaced apart packing units between upper and lower end portions of the mandrel and sleeve, the packing units preventing leakage of fluid between the mandrel and sleeve;

(d) the sleeve comprising an inlet port positioned between the spaced bearings;

10 (e) the mandrel comprising a plurality of spaced apart radial ports in fluid communication with both the inlet port and the longitudinal passage to supply pressurized fluid from the inlet port to the longitudinal passage and in the passage in drill or work string sections; and

(f) wherein each of the packing units comprise a plurality of packing rings, at least one packing ring in each packing unit being comprised of a mixture of teflon and carbon and at least one other packing ring in each packing unit being comprised of aramid.

35. The top drive swivel of claim 34, wherein each packing unit comprises six packing rings, three being comprised of a mixture of teflon and carbon and three being comprised of aramid.

20 36. The top drive swivel of claim 35, wherein each packing unit further comprises a first female packing end, a second female packing end, and a male packing end.

37. The top drive swivel of claim 34, wherein no rings of similar composition are placed adjacent each other.

25 38. The top drive swivel of claim 36, wherein each packing unit further comprises a packing injection ring.

30 39. The top drive swivel of claim 38, wherein the rings and ends of each packing unit are arranged as follows: female packing end, ring comprised of a mixture of teflon and carbon, ring comprised of aramid, packing injection ring, female packing end, ring comprised of a mixture of teflon and carbon, ring comprised of aramid, ring comprised of a mixture of teflon and carbon, ring comprised of aramid, and male

packing injection end.

40. The top drive swivel of claim 34, further comprising a pair of packing retainer nuts threadably engaging the sleeve, each packing retainer nut engaging one of the packing units.

5           41. The top drive swivel of claim 40, wherein the sleeve further comprises a protruding section, the protruding section engaging each of the packing units.

42. A top drive swivel insertable into a drill or work string comprising:

          (a) a mandrel having upper and lower end sections and connected to and rotatable with upper and lower drill or work string sections, the mandrel including a  
10 longitudinal passage forming a continuation of a passage in the drill or work string sections;

          (b) a sleeve having a longitudinal sleeve passage, the sleeve being rotatably connected to the mandrel by a pair of longitudinally spaced bearings;

          (c) a pair of spaced apart packing units between upper and lower end portions  
15 of the mandrel and sleeve, the packing units preventing leakage of fluid between the mandrel and sleeve;

          (d) the sleeve comprising an inlet port positioned between the spaced bearings;

          (e) the mandrel comprising a plurality of spaced apart radial ports in fluid communication with both the inlet port and the longitudinal passage to supply  
20 pressurized fluid from the inlet port to the longitudinal passage and in the passage in drill or work string sections; and

          (f) a spray welding coating on the mandrel, at least on the areas engaging the packing units, the spray welding coating comprising chromium, manganese, silicon; and iron.

25           43. The top drive swivel of claim 42, wherein the spray coating comprises chromium 30 percent; boron 6 percent; manganese 3 percent; silicon 3 percent; and iron balance.